Agilent E3632A DC Power Supply

Service Guide

Agilent Technologies

Notices

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Agilent Technologies, Inc.
5301, Stevens Creek Blvd.
Santa Clara, CA 95051 USA

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Safety Notices

CAUTION

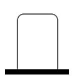
A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the likes of that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the likes of that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Safety Symbols

The following symbols on the instrument and in the documentation indicate precautions which must be taken to maintain safe operation of the instrument.

⚠	Caution, risk of danger (refer to this manual for specific Warning or Caution information)		In position of a bi-stable push control
⎓	DC (Direct current or voltage)	⊥	Terminal is at earth potential. Used for measurement and control circuits designed to be operated with one terminal at earth potential.
∼	AC (Alternating current or voltage)	+	Positive binding post
⏚	Protective conductor terminal	−	Negative binding post
	Out position of a bi-stable push control	⏚	Earth (ground) terminal

Safety Considerations

Read the information below before using this instrument.

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards for design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer’s failure to comply with these requirements.

CAUTION

- Use the device with the cables provided with the shipment.
- If the device is used in a manner not specified by the manufacturer, the device protection may be impaired.
- Always use a dry cloth to clean the device. Do not use ethyl alcohol or any other volatile liquid to clean the device.
- Do not permit any blockage of the ventilation holes of the device.

WARNING

- **Do not use MAINS supply cords by inadequately RATED cord. Always use the MAINS supply cord provided by the manufacturer.**
- **Do not use the device if it appears damaged or defective. REMOVE POWER and do not use the device until safe operation is verified by service-trained personnel. If necessary, return the device to Agilent for service and repair to ensure that the safety features are maintained.**
- **Do not operate the device around flammable gases or fumes, vapor, or wet environments.**
- **Observe all markings on the device before connecting any wiring to the device.**
- **Turn off the output of the power supply before connecting to the output terminals.**
- **When servicing the device, use only the specified replacement parts.**
- **Do not install substitute parts or perform any unauthorized modification to the device. Return the device to Agilent for service and repair to ensure that the safety features are maintained.**
- **Do not operate the device with the cover removed or loosened.**

This power supply is a Safety Class I instrument, which means that it has a protective earth terminal. That terminal must be connected to earth ground through a power source with a 3-wire ground receptacle.

Before installation or operation, check the power supply and review this manual for safety markings and instructions. Safety information for specific procedures is located at the appropriate places in this manual.

Safety and EMC Requirements

This power supply is designed to comply with the following safety and Electromagnetic Compatibility (EMC) requirements:

- IEC61326-1:2005/EN61326-1:2006
- Canada: ICES/NMB-001: Issue 4, June 2006
- Australia/New Zealand: AS/NZS CISPR11:2004
- IEC 61010-1:2001/EN 61010-1:2001
- Canada: CAN/CSA-C22.2 No. 61010-1-04
- USA: ANSI/UL 61010-1:2004

Environmental Conditions

This instrument is designed for indoor use and in an area with low condensation. The table below shows the general environmental requirements for this instrument.

Environmental condition	Requirements
Temperature	Operating condition • 0 °C to 40 °C (full rated output) Storage condition • –20 °C to 70 °C
Humidity	Up to 80% RH
Altitude	Up to 2000 m
Installation category	II (for indoor use)
Pollution degree	2

Regulatory Markings

CE ISM 1-A	The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives.	N10149	The C-tick mark is a registered trademark of the Spectrum Management Agency of Australia. This signifies compliance with the Australia EMC Framework regulations under the terms of the Radio Communication Act of 1992.
ICES/NMB-001	ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001. Cet appareil ISM est confomre a la norme NMB-001 du Canada.		This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.
C US	The CSA mark is a registered trademark of the Canadian Standards Association.	40	This symbol indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.
	This symbol is a South Korean Class A EMC Declaration. This is a Class A instrument suitable for professional use and in electromagnetic environment outside of the home.		

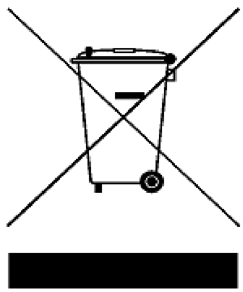
Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

Product Category:

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a “Monitoring and Control Instrument” product.

The affixed product label is as shown below.



Do not dispose in domestic household waste.

To return this unwanted instrument, contact your nearest Agilent Service Center, or visit

www.agilent.com/environment/product

for more information.

Declaration of Conformity (DoC)

The Declaration of Conformity (DoC) for this instrument is available on the Agilent Web site. You can search the DoC by its product model or description at the Web address below.

http://regulations.corporate.agilent.com/DoC/search.htm

NOTE If you are unable to search for the respective DoC, contact your local Agilent representative.

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1
Calibration Procedures

This chapter contains procedures to verify that the power supply is operating normally and is within published specifications.

Closed-Case Electronic Calibration

The power supply features closed-case electronic calibration since no internal mechanical adjustments are required for normal calibration. The power supply calculates correction factors based upon the input reference value you enter. The new correction factors are stored in non-volatile memory until the next calibration adjustment is performed. (Non-volatile memory does not change when power has been switched off or after a remote interface reset.)

Agilent Calibration Services

When your power supply is due for calibration, contact your local Agilent Service Center for a low-cost calibration. The Agilent E3632A power supply is supported on calibration processes which allow Agilent to provide this service at competitive prices.

Calibration Interval

The power supply should be calibrated on a regular interval determined by the accuracy requirements of your application. A 1-year interval is adequate for most applications. Agilent does not recommend extending calibration intervals beyond 1 year for any application. Agilent recommends that complete re-adjustment should always be performed at the calibration interval. This will increase your confidence that the Agilent E3632A will remain within specification for the next calibration interval. This criterion for re-adjustment provides the best long-term stability.

Automating Calibration Procedures

You can automate the complete verification procedures outlined in this chapter if you have access to programmable test equipment. You can program the instrument configurations specified for each test over the remote interface. You can then enter readback verification data into a test program and compare the results to the appropriate test limit values.

You can also enter calibration constants from the remote interface. Remote operation is similar to the local front-panel procedure. You can use a computer to perform the adjustment by first selecting the required setup. The calibration value is sent to the power supply and then the calibration is initiated over the remote interface. The power supply must be unsecured prior to initiating the calibration procedure. An Agilent BASIC program for calibration over the GPIB interface is listed at the end of this chapter.

For further details on programming the power supply, see chapters 3 and 4 in the *Agilent E3632A User's Guide*.

Recommended Test Equipment

The test equipment recommended for the performance verification and adjustment procedures is listed below. If the exact instrument is not available, use the accuracy requirements shown to select substitute calibration standards.

Table 1-1 Recommended test equipment

Instrument	Requirements	Recommended model	Test function
GPIB controller	Full GPIB capabilities	Agilent 82341C Interface card	Programming and readback accuracy.
Oscilloscope	100 MHz with 20 MHz bandwidth	Agilent 54602B	Display transient response and ripple and noise waveform.
RMS voltmeter	20 MHz		Measure rms ripple and noise.
Digital voltmeter	Resolution: 0.1 mV Accuracy: 0.01%	Agilent 34401A	Measure DC voltages.
Electronic load	Voltage Range: 50 Vdc Current Range: 10 Adc Open and Short Switches Transient On/Off	Agilent 6063B	Measure load and line regulations and transient response time.
Resistive loads (R_L)	2.1 Ω, 200 W 7.5 Ω, 200 W		Measure ripple and noise.
Current monitoring resistor (shunt)	0.01 Ω, 0.01%		Constant current test setup.

Test Considerations

To ensure proper instrument operation, verify that you have selected the correct power-line voltage prior to attempting any test procedure in this chapter. Refer to the *E3632A User's Guide* for more information.

For optimum performance verification, all test procedures should comply with the following recommendations.

- Assure that the calibration ambient temperature is stable and between 20 °C and 30 °C.
- Assure ambient relative humidity is less than 80%.
- Allow a 1-hour warm-up period before verification or calibration.
- Keep cables as short as possible, consistent with the impedance requirements.

CAUTION The tests should be performed by qualified personnel. During performance verification tests, hazardous voltages may be present at the outputs of the power supply.

Performance Verification Tests

The performance verification tests use the power supply's specifications listed in the *E3632A User's Guide*.

You can perform two different levels of performance verification tests:

- **Self-test**
  A series of internal verification tests that provides high confidence that the power supply is operational.
- **Performance verification tests**
  These tests can be used to verify the power supply specifications following repairs to specific circuits.

Self-test

A power-on self-test occurs automatically when you turn on the power supply. This limited test assures you that the power supply is operational.

The complete self-test is enabled by pressing the `Recall` key (actually any front panel keys except the `Error` key) and the power-line switch simultaneously and then continuing to press the `Recall` key for 5 seconds. The complete self-test will be finished in 2 more seconds.

You can also perform a self-test from the remote interface (see chapter 3 in the *E3632A User's Guide*).

- If the self-test is successful, **PASS** is displayed on the front panel.
- If the self-test fails, **FAIL** is displayed and the **ERROR** annunciator turns on. If repair is required, see Chapter 2, "Service" for further details.
- If self-test passes, you have a high confidence that the power supply is operational.

Performance verification tests

These tests can be used to verify the power supply specifications following repairs to specific circuits. The following sections explain all verification procedures in detail. All of the performance test specifications are shown in each test.

Measurement Techniques

Setup for most tests

Most tests are performed at the front terminals as shown in the following figure. Measure the DC voltage directly at the (+) and (−) terminals on the front panel.

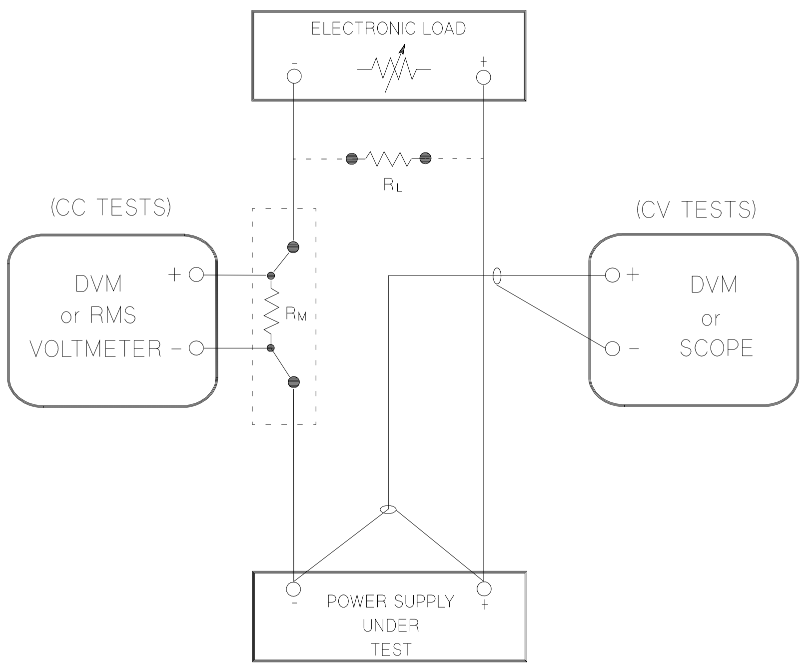

Figure 1-1 Performance verification test setup

Electronic load

Many of the test procedures require the use of a variable load resistor capable of dissipating the required power. Using a variable load resistor requires that switches be used to connect, disconnect, and short the load resistor. An electronic load, if available, can be used in place of a variable load resistor and switches. The electronic load is considerably easier to use than load resistors. It eliminates the need for connecting resistors or rheostats in parallel to handle power, it is much more stable than carbon-pile load, and it makes easy work of switching between load conditions as is required for the load regulation and load transient response tests. Substitution of the electronic load requires minor changes to the test procedures in this chapter.

Current-monitoring resistor

To eliminate output current measurement error caused by the voltage drops in the leads and connections, connect the current monitoring resistor between the (–) output terminal and the load as a four-terminal device. Connect the current-monitoring leads inside the load-lead connections directly at the monitoring points on the resistor element (see R_M in Figure 1-1).

Programming

Most performance tests can be performed only from the front panel. However, a GPIB or RS-232 controller is required to perform the voltage and current programming accuracy and readback accuracy tests.

The test procedures are written assuming that you know how to program the power supply either from the front panel or from a GPIB or RS-232 controller. Complete instructions on front panel and remote programming are given in the *E3632A User's Guide*.

Constant Voltage (CV) Verifications

Constant voltage test setup

If more than one meter or a meter and an oscilloscope are used, connect each to the (+) and (–) terminals by a separate pair of leads to avoid mutual coupling effects. Use a coaxial cable or shielded 2-wire cable to avoid noise pick-up on the test leads.

Voltage programming and readback accuracy

This test verifies that the voltage programming and the GPIB or RS-232 readback functions are within specifications. Note that the readback values over the remote interface should be identical to those displayed on the front panel.

NOTE You should program the power supply over the remote interface for this test to avoid round-off errors.

1 Turn off the power supply and connect a digital voltmeter between the (+) and (–) terminals of the output to be tested as shown in Figure 1-1.
2 Turn on the power supply. Select the 30 V/4 A range and enable the outputs by sending the commands:

```
VOLT:RANG P30V
OUTP ON
```

3 Program the output voltage to zero volt and current to full rated value (4.0 A) by sending the commands:

```
VOLT 0
CURR 4
```

4 Record the output voltage reading on the digital voltmeter (DVM). The reading should be within the limits of 0 V ±10 mV. Note that the **CV**, **Adrs**, **Limit**, and **Rmt** annunciators are on.

5 Readback the output voltage over the remote interface by sending the command:

```
MEAS:VOLT?
```

6 Record the value displayed on the controller. This value should be within the limits of DVM ±5 mV.

7 Program the output voltage to full rated value (30.0 V) by sending the command.

```
VOLT 30.0
```

8 Record the output voltage reading on the digital voltmeter (DVM). The readings should be within the limits of 30 V ±25 mV.

9 Readback the output voltage over the remote interface by sending the command:

```
MEAS:VOLT?
```

10 Record the value displayed on the controller. This value should be within the limits of DVM ±20 mV.

CV load regulation

This test measures the immediate change in the output voltage resulting from a change in the output current from full to no load.

1 Turn off the power supply and connect a digital voltmeter between the (+) and (–) terminals of the output to be tested as shown in Figure 1-1.

2 Turn on the power supply. Select the 30 V/4 A range, enable the output, and set the display to the limit mode. When the display is in the limit mode, program the output current to the maximum programmable value and the voltage to the full rated value (30.0 V).

3 Operate the electronic load in constant current mode and set its current to 4.0 A. Check that the front panel **CV** annunciator remains lit. If not lit, adjust the load so that the output current drops slightly until the **CV** annunciator lights. Record the output voltage reading on the digital voltmeter.

4 Operate the electronic load in open mode (input off). Record the output voltage reading on the digital voltmeter immediately. The difference between the digital voltmeter readings in steps 3 and 4 is the CV load regulation. The difference of the readings during the immediate change should be within the limit of 5 mV.

CV line regulation

This test measures the immediate change in output voltage that results from a change in AC line voltage from the minimum value (10% below the nominal input voltage) to maximum value (10% above the nominal input voltage).

1 Turn off the power supply and connect a digital voltmeter between the (+) and (–) terminals of the output to be tested as shown in Figure 1-1.

2 Connect the AC power line through a variable voltage transformer.

3 Turn on the power supply. Select the 30 V/4 A range, enable the output, and set the display to the limit mode. When the display is in the limit mode, program the current to the maximum programmable value and the voltage to full rated value (30.0 V).

4 Operate the electronic load in constant current mode and set its current to 4.0 A. Check that the **CV** annunciator remains lit. If not lit, adjust the load so that the output current drops slightly until the **CV** annunciator lights.

5 Adjust the transformer to low line voltage limit (104 Vac for nominal 115 Vac, 90 Vac for nominal 100 Vac, or 207 Vac for nominal 230 Vac). Record the output reading on the digital voltmeter.

6. Adjust the autotransformer to high line voltage (127 Vac for nominal 115 Vac, 110 Vac for nominal 100 Vac, or 253 Vac for nominal 230 Vac). Record the voltage reading on the digital voltmeter immediately. The difference between the digital voltmeter readings in steps 5 and 6 is the CV line regulation. The difference of the readings during the immediate change should be within the limit of 5 mV.

Normal mode voltage noise (CV ripple and noise)

The normal mode voltage noise is in the form of ripple related to the line frequency plus some random noise. The normal mode voltage noise is specified as the rms or peak-to-peak output voltage in a frequency range from 20 Hz to 20 MHz.

1. Turn off the power supply and connect the output to be tested as shown in Figure 1-1 to an oscilloscope (AC coupled) between (+) and (–) terminals. Set the oscilloscope to AC mode and bandwidth limit to 20 MHz. Connect a resistive load (7.5 Ω) as shown in Figure 1-1.
2. Turn on the power supply. Select the 30 V/4 A range, enable the output, and set the display to the limit mode. When the display is in the limit mode, program the current to the full rated value (4.0 A) and the voltage to the full rated value (30.0 V).
3. Check that the front panel **CV** annunciator remains lit. If not lit, adjust the load down slightly.
4. Note that the waveform on the oscilloscope does not exceed the peak-to-peak limit of 2 mV.
5. Disconnect the oscilloscope and connect an AC RMS voltmeter in its place. The rms voltage reading does not exceed the rms limit of 0.35 mV.

Load transient response time

This test measures the time for the output voltage to recover to within 15 mV of nominal output voltage following a load change from full load to half load, or half load to full load.

1. Turn off the power supply and connect the output to be tested as shown in Figure 1-1 with an oscilloscope. Operate the electronic load in constant current mode.
2. Turn on the power supply. Select the 30 V/4 A range, enable the outputs, and set the display to the limit mode. When the display is in the limit mode, program the current to the full rated value 4.0 A and the voltage to the full rated value (30.0 V).
3. Set the electronic load to transient operation mode between one half of the output's full scale value and the output's full rated value at a 1 kHz rate with 50% duty cycle.
4. Set the the oscilloscope for AC coupling, internal sync, and lock on either the positive or negative load transient.
5. Adjust the the oscilloscope to display transients as shown in Figure 1-2. Note that the pulse width (t_2–t_1) of the transients at 15 mV from the base line is no more than 50 msec for the output.

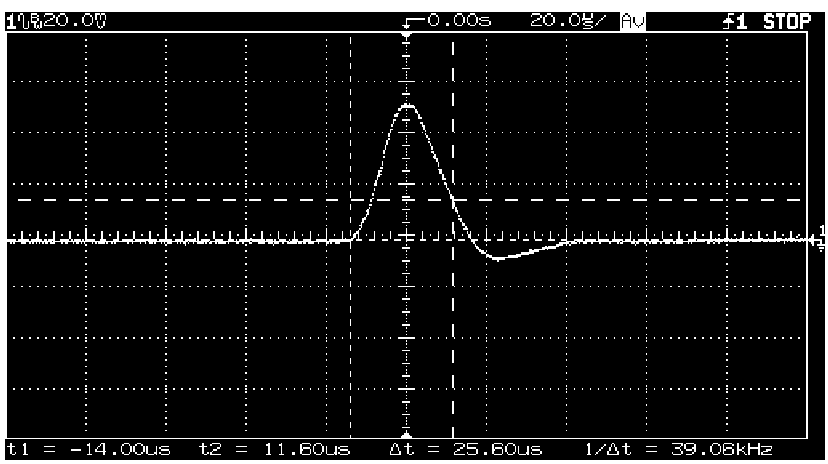

Figure 1-2 Transient response time

Constant Current (CC) Verifications

Constant current test setup

Follow the general setup instructions in the “Measurement Techniques” on page 8 and the specific instructions given in the following paragraphs.

Current programming and readback accuracy

This test verifies that the current programming and the GPIB or RS-232 readback functions are within specifications. Note that the readback values over the remote interface should be identical to those displayed on the front panel. The accuracy of the current monitoring resistor must be 0.01% or better.

NOTE You should program the power supply over the remote interface for this test to avoid round-off errors.

1 Turn off the power supply and connect a 0.01 Ω current monitoring resistor (R_M) across the output to be tested and a digital voltmeter (DVM) across the current monitoring resistor (R_M).

2 Turn on the power supply. Select the 15 V/7 A range and enable the output by sending the commands:

```
VOLT:RANG P15V
OUTP ON
```

3 Program the output voltage to full rated voltage (15.0 V) and output current to zero amp by sending the commands:

```
VOLT 15
```

```
CURR 0
```

4 Divide the voltage drop (DVM reading) across the current monitoring resistor (R_M) by its resistance to convert to amps and record this value (I_O). This value should be within the limits of 0 A ±10 mA. Also, note that the **CC**, **Adrs**, **Limit**, and **Rmt** annunciators are on.

5 Readback the output current over the remote interface by sending the command:

```
MEAS:CURR?
```

6 Record the value displayed on the controller. This value should be within the limit of I_O ±5 mA.

7 Program the output current to the full rated value (7.0 A) by sending the commands:

```
CURR 7.0
```

8 Divide the voltage drop (DVM reading) across the current monitoring resistor (R_M) by its resistance to convert to amps and record this value (I_O). This value should be within the limit of 7 A ±24 mA.

9 Readback the output current over the remote interface by sending the command:

```
MEAS:CURR?
```

10 Record the value displayed on the controller. This value should be within the limit I_O ±15.5 mA.

CC load regulation

This test measures the immediate change in output current resulting from a change in the load from full-rated output voltage to short circuit.

1 Turn off the power supply and connect the output to be tested as shown in Figure 1-1 with the digital voltmeter connected across the 0.01Ω current monitoring resistor (R_M).

2 Turn on the power supply. Select the 15 V/7 A range, enable the output, and set the display to the limit mode. When the display is in the limit mode, program the output voltage to the maximum programmable value and the output current to the full rated value (7.0 A).

3 Operate the electronic load in constant voltage mode and set its voltage to 15.0 V. Check that the **CC** annunciator is on. If it is not, adjust the load so that the output voltage drops slightly. Record the current reading by dividing the voltage reading on the digital voltmeter by the resistance of the current monitoring resistor.

4 Operate the electronic load in short (input short) mode. Record the current reading immediately by dividing the voltage reading on the digital voltmeter by the resistance of the current monitoring resistor. The difference between the current readings in step 3 and 4 is the load regulation current. The difference of the readings during the immediate change should be within the limit of 0.95 mA.

CC line regulation

This test measures the immediate change in output current that results from a change in AC line voltage from the minimum value (10% below the nominal input voltage) to the maximum value (10% above nominal voltage).

1 Turn off the power supply and connect the output to be tested as shown in Figure 1-1 with the digital voltmeter connected across the current monitoring resistor (R_M).

2 Connect the AC power line through a variable voltage transformer.

3 Turn on the power supply. Select the 15 V/7 A range, enable the output, and set the display to the limit mode. When the display is in the limit mode, program the ouput voltage to the maximum programmable value and the output current to the full rated value (7.0 A).

4 Operate the electronic load in constant voltage mode and set its voltage to 15.0 V. Check that the **CC** annunciator remains lit. If not lit, adjust the load so that the output voltage drops slightly until the **CC** annunciator lights.

5 Adjust the transformer to low line voltage limit (104 Vac for nominal 115 Vac, 90 Vac for nominal 100 Vac, or 207 Vac for nominal 230 Vac). Record the output current reading by dividing the voltage reading on the digital voltmeter by the resistance of the current monitoring resistor.

6 Adjust the transformer to 10% above the nominal line voltage (127 Vac for a 115 Vac nominal input, 110 Vac for a 100 Vac nominal input or 253 Vac for a 230 Vac nominal input). Record the current reading again immediately by dividing the voltage reading on the digital voltmeter by the resistance of the current monitoring resistor. The difference between the current readings in step 5 and 6 is the load regulation current. The difference of the readings during the immediate change should be within the limit of 0.95 mA.

Normal mode current noise (CC ripple and noise)

The normal mode current noise is specified as the rms output current in a frequency range 20 Hz to 20 MHz with the power supply in constant current operation.

1 Turn off the power supply and connect the output to be tested as shown in Figure 1-1 with a load resistor (2.1 Ω) across output terminals to be tested. Connect a RMS voltmeter across the load resistor. Use only a resistive load for this test.

2 Turn on the power supply. Select the 15 V/7 A range, enable the output, and set the display to the limit mode. When the display is in the limit mode, program the current to full rated value (7.0 A) and the voltage to the full rated value (15.0 V).

3 The output current should be at the full-rated rating with the **CC** annunciator on. If not lit, adjust the load so that the output voltage drops slightly until the **CC** annunciator lights.

4 Divide the reading on the RMS voltmeter by the load resistance to obtain rms current. The readings should be within the limit of 2 mA.

Common Mode Current Noise

The common mode current is that AC current component which exists between the output or output lines and chassis ground. Common mode noise can be a problem for very sensitive circuitry that is referenced to earth ground. When a circuit is referenced to earth ground, a low level line-related AC current will flow from the output terminals to earth ground. Any impendance to earth ground will create a voltage drop equal to the output current flow multiplied by the impendance.

1. Turn off the power supply and connect a 100 KΩ resistor (R_S) and a 2200 pF capacitor in parallel between the (–) terminal and chassis ground.
2. Connect a digital voltmeter (DVM) across R_S.
3. Turn on the power supply. Select the 15 V/7 A range, enable the output, and set the display to the limit mode. When the display is in the limit mode, program the output to the full rated value (15.0 V and 7.0 A).
4. Record the voltage across R_S and convert it to current by dividing by the resistance (DVM reading/100 KΩ). Note that the current is less than 1.5 μA.

Performance Test Record for E3632A

CV performance test record

Table 1-2 CV performance test record

Test description	Actual result	Specifications	
		Upper limit	Lower limit
CV programming accuracy @ 0 volts (DVM reading)		+0.0100 V	–0.0100 V
CV readback accuracy @ 0 volts		DVM + 0.0050 V	DVM – 0.0050 V
CV programming accuracy @ full scale (DVM reading)		+30.025 V	29.9750 V
CV readback accuracy @ full scale		DVM + 0.0200 V	DVM – 0.0200 V
CV load regulation		Maximum change: <5 mV	
CV line regulation		Maximum change: <5 mV	
CV ripple/noise		<2 mVp-p, 0.35 mVrms	
Load transient response time		<50 μsec	

CC performance test record

Table 1-3 CC performance test record

Test Description	Actual Result	Specifications	
		Upper Limit	Lower Limit
CC programming accuracy @ 0 A (I_O)		+0.0100 A	–0.0100 A
CC readback accuracy @ 0 A		I_O + 0.0050 A	I_O – 0.0050 A
CC programming accuracy @ full scale (I_O)		7.0240 A	6.9760 A
CC readback accuracy @ full scale		I_O + 0.0155 A	I_O – 0.0155 A
CC load regulation		Maximum change: <0.95 mA	
CC line regulation		Maximum change: <0.95 mA	
CC ripple/noise		<2 mA	
Common mode current noise		<1.5 µArms	

Calibration Security Code

This feature allows you to enter a security code (electronic key) to prevent accidental or unauthorized calibrations of the power supply. When you first receive your power supply, it is secured. Before you can calibrate the power supply, you must unsecure it by entering the correct security code. A procedure to unsecure the power supply is given on the following page.

- The security code is set to **HP003632** when the power supply is shipped from the factory. The security code is stored in non-volatile memory, and it does not change when power has been off or after a remote interface reset.
- To secure the power supply from the remote interface, the security code may contain up to 12 alphanumeric characters as shown below. The first character must be a letter, but the remaining characters can be letters or numbers. You do not have to use all 12 characters but the first character must always be a letter.

  A _ _ _ _ _ _ _ _ _ _ _ (12 characters)
- To secure the power supply from the remote interface so that it can be unsecured from the front panel, use the eight-character format shown below. The first two characters must be "H P" and the remaining characters must be numbers. Only the last six characters are recognized from the front panel, but all eight characters are required. To unsecure the power supply from the front panel, omit the "H P" and enter the remaining numbers as shown on the following pages.

  H P _ _ _ _ _ _ (8 characters)
- If you forget your security code, you can disable the security feature by adding a jumper inside the power supply, and then entering a new code. Refer to "To unsecure the power supply without the security code" on page 26.

To unsecure the power supply for calibration

The power supply can use a calibration security code to prevent unauthorized or accidental calibration. This procedure shows you how to unsecure the power supply for calibration from the front panel.

Calibrate
Power

1 *Turn on the front- panel calibration mode.*

SECURED

Turn on the calibration mode by pressing the **Calibrate** key while simultaneously turning on the power supply then continue to hold the **Calibrate** key for about 5 seconds until a beep is heard.

If the power supply is secured, you will see the above message from the front panel for approximately one second. The **CAL MODE** message is then displayed on the front panel.

Secure

2 *Move to the security code by pressing the* ***Secure*** *key.*

000000 CODE

3 *Enter the security code using the knob and resolution selection keys.*

003632 CODE

The security code is set to "**HP003632**" when the power supply is shipped from the factory. The security code is stored in non-volatile memory and does not change when the power has been off or after a remote interface reset.

To enter the security code from the front panel, enter only the last six digits. To enter the security code from the remote interface, you may enter up to 12 characters.

Use the resolution selection keys to move left or right between digits. Use the knob to change the digits. Notice that the security code may be different if the security code has been changed from the default setting.

Secure

4 *Unsecure the power supply.*

UNSECURED

The power supply is unsecured when you press the Secure key. You will see the above message from the front panel for one second. The **CAL MODE** message is displayed on the front panel after above message.

Power

5 *Turn off the calibration mode.*

Turn off the power supply to exit the calibration mode.

NOTE To re-secure the power supply (following calibration), perform this procedure again.

To unsecure the power supply without the security code

To unsecure the power supply without the correct security code (when you forget the security code), follow the steps below. Refer to "Electrostatic Discharge (ESD) Precautions" on page 51 before beginning this procedure.

1 Disconnect the power cord and all load connections from front terminals.

2 Remove the instrument cover.

3 Connect the power cord and turn on the calibration mode by pressing the **Calibrate** key while simultaneously turning on the power supply, and then continue to hold the **Calibrate** key for about 5 seconds until a beep is heard. Be careful not to touch the power line connections.

4 Apply a short between the two exposed metal pads on JP5[1] (located near U13). Refer to "Component locator diagram for the main board assembly — top" on page 61.

5 While maintaining the short, press Secure to move to the security code and enter any unsecure code in the calibration mode. The power supply is now unsecured.

[1] For serial MY53xx6xxx, apply the short at JP12 (located near U36). Refer to "Component locator diagram for the main board assembly — top (serial MY53xx6xxx)" on page 63.

6 Remove the short at JP5[1]. (An error occurs if not removed.)

7 Turn off and reassemble the power supply. Now you can enter a new security code. Be sure you take note of the new security code.

[1] For serial MY53xx6xxx, remove the short at JP12.

Calibration Count

The calibration count feature provides an independent "serialization" of your calibrations. You can determine the number of times that your power supply has been calibrated. By monitoring the calibration count, you can determine whether an unauthorized calibration has been performed. Since the value increments by one for each calibration parameter (see Table 1-4 on the next page), a complete calibration increases the value by 5 counts.

The calibration count is stored in non-volatile memory and does not change when power has been off or after a remote interface reset. Your power supply was calibrated before it left the factory. When you receive the power supply, read the calibration count to determine its value.

The calibration count increments up to a maximum of 32,767 after which it wraps around to 0. No way is provided to program or reset the calibration count.

Calibration Message

You can use the calibration message feature to record calibration information about your power supply. For example, you can store such information as the last calibration date, the next calibration due date, the power supply's serial number, or even the name and phone number of the person to contact for a new calibration.

You can record and read information in the calibration message from the remote interface only.

The calibration message may contain up to 40 characters.

The calibration message is stored in non-volatile memory and does not change when power has been off or after a remote interface reset.

General Calibration/Adjustment Procedure

The calibration procedures from the front panel are described in this section. For voltage calibration, disconnect all loads from the power supply and connect a DVM across the output terminals. For current calibration, disconnect all loads from the power supply, connect an appropriate current monitoring resistor (0.01 Ω) across the output terminals, and connect a DVM across the terminals of the monitoring resistor.

NOTE The power supply should be calibrated after 1-hour warm-up with no load connected.

The following table shows calibration parameters and points which should be used to calibrate the output voltage and current.

Table 1-4 Parameters for calibration

Calibration parameter	Voltage/current	Calibration point mnemonic
CAL SETUP 1	Voltage	V LO
		V MI
		V HI
CAL SETUP 2	OVP	None
CAL SETUP 3	Current	I LO
		I MI
		I HI
CAL SETUP 4	OCP	None

NOTE

- You can terminate any CAL SETUP without changing its calibration constants by turning off power.
- Perform the voltage calibration prior to the OVP calibration and the current calibration prior to the OCP calibration.

To calibrate the output voltages and currents of the power supply from the front panel, proceed as follows:

1 *Unsecure the power supply.*

To calibrate the voltage and current, you must unsecure the power supply according to the procedure given on page 59.

2 *Disconnect all loads from the power supply and connect a DVM across output terminals.*

Calibrate
Power

3 *Turn on the calibration mode.*

CAL MODE

Turn on the calibration mode by pressing the **Calibrate** key while simultaneously turning on the power supply, and then continue to hold the **Calibrate** key for about 5 seconds until a beep is heard. Make sure that the power supply is in CV mode. If the power supply is not in CV mode, an error occurs.

Voltage and OVP calibration

Calibrate

4 *Move down a level to the voltage calibration mode.*

CAL SETUP 1

The display shows the above message to indicate that the power supply is ready for the voltage calibration.

Calibrate

5 *Calibrate DAC and select the low voltage calibration point.*

30 LEFT

The **START BITCAL** message is displayed for about 3 seconds to indicate that the power supply is ready for DAC calibration. Then it counts down numbers from 30 to 0.

V LO 0.5000 V

Then, the display shows the low voltage calibration point.

6 *Read the DVM and change the low voltage value on the display to match the measured voltage.*

For example, if the DVM reading is 0.4500 V, adjust the voltage to 0.4500 V using the knob and resolution selection keys.

V LO 0.4500 V

Calibrate

7 *Pressing the* ***Calibrate*** *key saves the change and selects the middle voltage calibration point.*

V MI 15.000 V

If the entered number is within an acceptable range, an **ENTERED** message appears for one second. If the entered number is not correct, a **MIN VALUE** or **MAX VALUE** message appears for one second and the display shows the low voltage calibration point again. The display now shows the middle voltage calibration point.

8 *Read the DVM and change the middle voltage value on the display to match the measured voltage.*

For example, if the DVM reads 14.995 V, adjust the voltage to 14.995 V using the knob and arrow keys.

V MI 14.995 V

`Calibrate`

9 *Pressing the* ***Calibrate*** *key saves the change and selects the high voltage calibration point.*

V HI 29.500 V

If the entered number is within an acceptable range, a **ENTERED** message appears for one second. If the entered number is not correct, a **MIN VALUE** or **MAX VALUE** message appears for one second and the display shows the middle voltage calibration point again. The display now shows the high voltage calibration point.

10 *Read the DVM and change the high voltage value on the display to match the measured voltage.*

For example, if the DVM reads 28.995 V, adjust the voltage to 28.995 V using the knob and arrow keys.

V HI 28.995 V

`Calibrate`

11 *Pressing the* ***Calibrate*** *key saves the new voltage calibration constants, and goes to the OVP calibration mode.*

CAL SETUP 2

A **CALIBRATING** message appears for one second to indicate that the voltage calibration is progressing and new voltage calibration constants of “SETUP 1” are stored. Then, the display shows above message to indicate that the power supply is ready for the OVP calibration.

If the calibration fails, a **DAC CAL FAIL** or **ADC CAL FAIL** message appears for one second and the display shows the **CAL SETUP 1** for voltage calibration again.

Current and OCP calibration

NOTE Connect an appropriate shunt (0.01 Ω) across the output terminals, and connect a digital voltmeter across the shunt resistor for the current calibration.

12 *Pressing the* ***Calibrate*** *key saves the new calibration constants for OVP circuit and goes to the current calibration mode.*

CAL SETUP 3

A **CALIBRATING** message appears for about several seconds to indicate that the OVP calibration is progressing and new calibration constants of “SETUP 2” are stored. Then, the display shows the above message to indicate that the power supply is ready for the current calibration.

If the calibration fails, a **OVP CAL FAIL** message appears for one second and the display shows the **CAL SETUP 2** for OVP calibration again.

Calibrate

13 *Select the low current calibration point.*

I LO 0.2000 A

The display shows the low current calibration point.

14 *Read the DVM and change the low current value on the display to match the computed current (DVM reading divided by shunt resistance).*

For example, if the computed value is 0.199 A, adjust the current to 0.199 A using the knob and arrow keys.

I LO +0.1990 A

NOTE Notice that you should wait for the DVM reading to stabilize for accurate calibration.

Calibrate

15 *Pressing the **Calibrate** key saves the change and selects the middle current calibration point.*

I MI 3.5000 A

If the entered number is within an acceptable range, an **ENTERED** message appears for one second. If the entered number is not correct, a **MIN VALUE** or **MAX VALUE** message appears for one second and the display shows the low current calibration point again. The display now shows the middle current calibration point.

16 *Read the DVM and change the middle current value on the display to match the computed current (DVM reading divided by shunt resistance).*

For example, if the computed value is 3.499 A, adjust the current to 3.499 A using the knob and arrow keys.

I MI 3.4990 A

NOTE Notice that you should wait for the DVM reading to stabilize for accurate calibration.

Calibrate

17 *Pressing the **Calibrate** key saves the change and selects the high current calibration point.*

I HI 6.9000 A

If the entered number is within an acceptable range, an **ENTERED** message appears for one second. If the entered number is not correct, a **MIN VALUE** or **MAX VALUE** message appears for one second and the display shows the middle current calibration point again. The display now shows the high current calibration point.

18 *Read the DVM and change the high current value on the display to match the computed current (DVM reading divided by shunt resistance).*

For example, if the computed value is 6.899 A, adjust the current to 6.899 A using the knob and arrow keys.

I HI 6.8990 A

NOTE Notice that you should wait for the DVM reading to stabilize for accurate calibration.

Calibrate

19 *Pressing the **Calibrate** key saves the new calibration constants for the output current and goes to the OCP calibration mode.*

CAL SETUP 4

A **CALIBRATING** message appears for one second to indicate that the current calibration is progressing and new calibration constants of “SETUP 3” are stored. Then, the display shows the above message to indicate that the power supply is ready for the OCP calibration.

If the calibration fails, a **DAC CAL FAIL** or **ADC CAL FAIL** message appears for one second and the display shows the **CAL SETUP 3** for current calibration again.

Calibrate

20 *Pressing the **Calibrate** key saves the new OCP calibration constants and return to the calibration mode.*

CAL MODE

A **CALIBRATING** message appears for several seconds to indicate that the OCP calibration is progressing and new OCP calibration constants of “SETUP 4” are stored. Then the display will return to the calibration mode.

Power

21 *Turn off the power supply to exit the calibration mode.*

Aborting a Calibration in Progress

Sometimes it may be necessary to abort a calibration after the procedure has already been initiated. You can abort a calibration at any time by turning the power supply off from the front panel. When performing a calibration from the remote interface, you can abort a calibration by issuing a remote interface device clear message or by pressing the front-panel **Local** key.

Calibration Record for E3632A

Table 1-5 Calibration record for E3632A

Step	Calibration Description	Measurement Mode (DVM)	Supply Being Adjusted
1	Unsecure the power supply (see "To unsecure the power supply for calibration" on page 25).		
2	Turn on CAL MODE (simultaneously press the **Calibrate** and **Power** keys) until it beeps.		
3	Move down menu to **CAL SETUP 1** (press the **Calibrate** key).		Voltage Calibration
4	Calibrate the DAC and select the low point for voltage calibration; "**START BITCAL** appears for 3 seconds and the display counts down numbers from 30 to 0. Then, "**V LO 0.5000 V**" appears on the display (press the **Calibrate** key and wait about 30 seconds, and change the display to match the DVM reading).	V	DAC and low voltage point calibration
5	"**V MI 15.000 V**" appears on the display (press the **Calibrate** key and change the display to match the DVM reading).	V	Middle voltage point calibration
6	"**V HI 29.500 V**" appears on the display (press the **Calibrate** key and change the display to match the DVM reading).	V	High voltage point calibration
7	"**CAL SETUP"** now appears on the display (press the **Calibrate** key).	V	OVP calibration
8	"**CAL SETUP 3**" now appears on the display (press the **Calibrate** key and connect 0.01 Ω resistor across the output terminals).		Current calibration
9	"**I LO 0.2000 A**" appears on the display (press the **Calibrate** key; then change the display to match the computed current through 0.01 Ω resistor).	A	Low current point calibration
10	"**I MI 3.5000 A**" appears on the display (press the **Calibrate** key; then change the display to match the computed current through 0.01 Ω resistor).	A	Middle current point calibration
11	"**I HI 6.9000 A**" appears on the display (press the **Calibrate** key and change the display to match the computed current through 0.01 Ω resistor).	A	High current point calibration
12	"**CAL SETUP 4**" now appears on the display (press the **Calibrate** key).	A	OCP calibration
13	Press the **Calibrate** key, and then press the **Power** switch.		Exit CAL MODE

Error Messages

The following tables are abbreviated lists of error messages for the E3632A. The errors listed are the most likely errors to be encountered during calibration and adjustment. A more complete list of error messages and descriptions is contained in “Chapter 4” of the *E3632A User's Guide*.

System error messages

Table 1-6 System error messages

Error	Error Message
-330	Self-test failed
-350	Queue overflow
501	Isolator UART framing error
502	Isolator UART overrun error
503[1]	SPI data error
511	RS-232 framing error
512	RS-232 overrun error
513	RS-232 parity error
514	Command allowed only with RS-232
521	Input buffer overflow
522	Output buffer overflow
550	Command not allowed in local

[1] This error message is only applicable for serial MY53xx6xxx.

Self-test error messages

Table 1-7 Self-test error messages

601	Front panel does not respond
602	RAM read/write failed
603	A/D sync stuck
604	A/D slope convergence failed
605	Cannot calibrate rundown gain
606	Rundown gain out of range
607	Rundown too noisy
608	Serial configuration readback failed
609[1]	System ADC test failed
624	Unable to sense line frequency
625	I/O processor does not respond
626	I/O processor failed self-test
630	Fan test failed
631	System DAC test failed
632	Hardware test failed

[1] This error message is only applicable for serial MY53xx6xxx.

Calibration error messages

Table 1-8 Calibration error messages

Error	Error message
701	Cal security disabled by jumper
702	Cal secured
703	Invalid secure code
704	Secure code too long
705	Cal aborted
708	Cal output disabled
712	Bad DAC cal data
713	Bad readback cal data
714	Bad OVP cal data
715	Bad OCP cal data
716	Bad OVP DNL error correction data
717	Cal OVP or OCP status enabled
740	Cal checksum failed, secure state
741	Cal checksum failed, string data
742	Cal checksum failed, store/recall data in location 0
743	Cal checksum failed, store/recall data in location 1
744	Cal checksum failed, store/recall data in location 2
745	Cal checksum failed, store/recall data in location 3
746	Cal checksum failed, DAC cal constants
747	Cal checksum failed, readback cal constants
748	Cal checksum failed, GPIB address
749	Cal checksum failed, internal data
750	Cal checksum failed, DAC DNL error correction data

Calibration Program

This section contains an Agilent BASIC program for calibration over the GPIB interface. This program makes software adjustments to the E3632A power supply using a current shunt and a digital mutimeter which is connected to the controller. In this program a 0.01 ohm current shunt is used. Be sure to change the value of the variable “Current_shunt” to the value of the current shunt used and the GPIB address for the power supply and the digital voltmeter.

```
10    !
20    ! This program was written on a PC with Agilent Basic for Windows.
30    ! It will make software adjustments to the E3632A Power Supply
40    ! on the GPIB bus using a Agilent 34401A Digital Multimeter and a
50    ! current shunt. In the program a 0.01 ohm current shunt is
60    ! used to measure current.  Be sure to change the value of
70    ! the variable 'Current_shunt' to the value of the current
80    ! shunt used.
90    !
100   CLEAR SCREEN
110   DIM Cal_msg$[40],Error$[40],Sec_code$[10]
120   REAL Dmm_rdg,Current_shunt
130   Current_shunt=.01              ! Current Shunt value in Ohms
140   Sec_code$="HP003632"            ! Assign the security code
150   ASSIGN @Dmm TO 722              ! Assign address 22 to the Dmm
160   ASSIGN @Pwrsupply TO 705        ! Assign address 5 to the Power Supply
170   CLEAR 7                         ! Clear GPIB, Dmm and Power Supply
180   OUTPUT @Pwrsupply;"*CLS"        ! Clear Power Supply errors
190   OUTPUT @Dmm;"*RST"              ! Reset Dmm
200   OUTPUT @Pwrsupply;"*RST"        ! Reset Power Supply
210   OUTPUT @Pwrsupply;"CAL:STR?"    ! Read the calibration message
220   ENTER @Pwrsupply;Cal_msg$
230   PRINT TABXY(5,2),"Calibration message of Power Supply is: ";Cal_msg$
240   !
250   ! Set the Calibration security to off, and check to be sure
260   ! it is off. If not successful, print message to screen and end.
270   !
280   OUTPUT @Pwrsupply;"VOLT:PROT:STAT OFF"
290   OUTPUT @Pwrsupply;"CURR:PROT:STAT OFF"
300   OUTPUT @Pwrsupply;"CAL:SEC:STAT OFF, ";Sec_code$
310   OUTPUT @Pwrsupply;"CAL:SEC:STAT?"
320   ENTER @Pwrsupply;A
```

```
330   IF A=1 THEN
340     PRINT TABXY(5,5),"****** Unable to Unsecure the Power supply ******"
350     GOTO 2290
360   END IF

370   !
380   ! Perform the DAC error correction, voltage calibration and OVP calibration.
390   ! Alert the operator to hook up the connection before calibrating.
400   !
410   ! Alert operator to connect lead
420    PRINT TABXY(10,10),"**********************************************************"
430   PRINT TABXY(10,11)," Prepare for E3632A DAC DNL error correction and"
440   PRINT TABXY(10,12)," Voltage/OVP calibration. Connect the output to the DMM."
450   PRINT TABXY(10,13)," Observe Polarity!"
460    PRINT TABXY(10,14),"**********************************************************"
470    PRINT TABXY(10,16),"Press 'C' to Continue, 'I' to go to CURRENT calibration or"
480   PRINT TABXY(10,17),"'X' to eXit, then press 'Enter'"
490   Ch$="C"
500   INPUT Ch$
510   IF Ch$="X" OR Ch$="x" THEN GOTO 2250
520   IF Ch$="I" OR Ch$="i" THEN
530     CLEAR SCREEN
540     GOTO 1460
550   END IF
560   CLEAR SCREEN
570   PRINT TABXY(10,7),"BEGIN DAC ERROR CORRECTION"
580   WAIT 4
590   CLEAR SCREEN
600   OUTPUT @Pwrsupply;"OUTP ON"               ! Turn on Power Supply output
610   OUTPUT @Pwrsupply;"CAL:DAC:ERROR"         ! Perform DAC DNL error correction
620   WAIT 29                                   ! Allow DAC error correction to finish
630   OUTPUT @Pwrsupply;"OUTPUT OFF"            ! Turn off Power Supply output
640   OUTPUT @Pwrsupply;"SYST:ERR?"
650   ENTER @Pwrsupply;Error$
660   !
670   ! Check to see if there is an error.  If there is an error,
680   ! display the error and exit the program.
690   !
700   CLEAR SCREEN
710   IF Error$="+0,""No error""" THEN
720     PRINT "DAC DNL Error Correction completed for Power Supply "
730   ELSE
740     PRINT "ERROR:";Error$;"DAC DNL Error not corrected "
750     BEEP
760     GOTO 2250
770   END IF
780   PRINT TABXY(10,5),"DAC DNL ERROR CORRECTION COMPLETE"
790   PRINT TABXY(10,7),"BEGIN VOLTAGE CALIBRATION"
```

```
800   WAIT 4
810   OUTPUT @Pwrsupply;"OUTPUT ON"
820   CLEAR SCREEN
830   OUTPUT @Pwrsupply;"CAL:VOLT:LEV MIN"      ! set output to minimum cal value
840   WAIT 2                                    ! allow output to settle
850   OUTPUT @Dmm;"MEAS:VOLT:DC?"               ! measure output with Dmm and
860   ENTER @Dmm;Dmm_rdg                        ! store in variable Dmm_rdg
870   PRINT Dmm_rdg

880   OUTPUT @Pwrsupply;"CAL:VOLT:DATA ";Dmm_rdg  ! send stored value to Power Supply
890   OUTPUT @Pwrsupply;"CAL:VOLT:LEV MID"      ! set output to middle cal value
900   WAIT 2                                    ! allow output to settle
910   OUTPUT @Dmm;"MEAS:VOLT:DC?"               ! measure output with Dmm and
920   ENTER @Dmm;Dmm_rdg                        ! store in variable Dmm_rdg
930   PRINT Dmm_rdg
940   OUTPUT @Pwrsupply;"CAL:VOLT:DATA ";Dmm_rdg  ! send stored value to Power Supply
950   OUTPUT @Pwrsupply;"CAL:VOLT:LEV MAX"      ! set output to maximum cal value
960   WAIT 2                                    ! allow output to settle
970   OUTPUT @Dmm;"MEAS:VOLT:DC?"               ! measure output with Dmm and
980   ENTER @Dmm;Dmm_rdg                        ! store in variable Dmm_rdg
990   PRINT Dmm_rdg
1000  OUTPUT @Pwrsupply;"CAL:VOLT:DATA ";Dmm_rdg  ! send stored value to Power Supply
1010  OUTPUT @Pwrsupply;"OUTP OFF"
1020  OUTPUT @Pwrsupply;"SYST:ERR?"
1030  ENTER @Pwrsupply;Error$
1040  !
1050  ! Check to see if there is an error.  If there is an error,
1060  ! display the error and exit the program.
1070  !
1080  CLEAR SCREEN
1090  IF Error$="+0,""No error""" THEN
1100    PRINT "Voltage calibration completed for Power Supply "
1110  ELSE
1120    PRINT "ERROR:";Error$;"Voltage not Calibrated"
1130    BEEP
1140    GOTO 2250
1150  END IF
1160  PRINT TABXY(10,5),"VOLTAGE CALIBRATION COMPLETE"
1170  PRINT TABXY(10,7),"BEGIN OVP CALIBRATION"
1180  WAIT 4
1190  CLEAR SCREEN
1200  OUTPUT @Pwrsupply;"OUTP ON"               ! Turn on Power Supply output
1210  OUTPUT @Pwrsupply;"CAL:VOLT:PROT"         ! Perform OVP circuit calibration
1220  WAIT 9                                    ! Allow OVP calibration to finish
1230  OUTPUT @Pwrsupply;"OUTP OFF"              ! Turn off Power Supply output
1240  OUTPUT @Pwrsupply;"SYST:ERR?"
1250  ENTER @Pwrsupply;Error$
```

```
1260  !
1270  ! Check to see if there is an error.  If there is an error,
1280  ! display the error and exit the program.
1290  !
1300  CLEAR SCREEN
1310  IF Error$="+0,""No error""" THEN
1320    PRINT "OVP calibration completed for Power Supply "
1330  ELSE
1340    PRINT "ERROR:";Error$;"OVP not Calibrated"
1350    BEEP
1360    GOTO 2250
1370  END IF

1380  CLEAR SCREEN
1390  PRINT TABXY(10,5),"DAC ERROR CORRECTION AND VOLTAGE/OVP CALIBRATION COMPLETE"
1400  WAIT 4
1410  !
1420  ! Perform the Current calibration and OCP calibration. Alert the operator to
1430  ! hook up the connection before calibrating.
1440  !
1450  ! Alert operator to connect lead
1460  PRINT TABXY(10,10),"**********************************************************"
1470  PRINT TABXY(10,11)," Connect a CURRENT SHUNT to the Dmm input for measuring"
1480  PRINT TABXY(10,12)," current. Connect the output to the shunt. Observe Polarity!"
1490  PRINT TABXY(10,13),"**********************************************************"
1500  PRINT TABXY(10,15),"Press 'C' to Continue, or 'X' to eXit, then 'Enter':"
1510  Ch$="C"
1520  INPUT Ch$
1530  IF Ch$="X" OR Ch$="x" THEN GOTO 2250
1540  OUTPUT @Pwrsupply;"OUTP ON"               ! Turn on Power Supply output
1550  CLEAR SCREEN
1560  PRINT TABXY(10,7),"BEGIN CURRENT/OCP CALIBRATION"
1570  WAIT 4
1580  CLEAR SCREEN
1590  OUTPUT @Pwrsupply;"CAL:CURR:LEVel MIN"    ! set output to minimum cal value
1600  WAIT 2                                    ! allow output to settle
1610  OUTPUT @Dmm;"MEAS:VOLT:DC? "              ! measure output with Dmm and
1620  ENTER @Dmm;Dmm_rdg                        ! store in variable Dmm_rdg
1630  Dmm_rdg=Dmm_rdg/Current_shunt             ! scale reading to amps
1640  PRINT Dmm_rdg
1650  OUTPUT @Pwrsupply;"CAL:CURR:DATA ";Dmm_rdg  ! send stored value to Power Supply
1660  OUTPUT @Pwrsupply;"CAL:CURR:LEVel MID"    ! set output to middle cal value
1670  WAIT 2                                    ! allow output to settle
1680  OUTPUT @Dmm;"MEAS:VOLT:DC? "              ! measure output with Dmm and
1690  ENTER @Dmm;Dmm_rdg                        ! store in variable Dmm_rdg
1700  Dmm_rdg=Dmm_rdg/Current_shunt             ! scale reading to amps
1710  PRINT Dmm_rdg
```

```
1720  OUTPUT @Pwrsupply;"CAL:CURR:DATA ";Dmm_rdg  ! send stored value to Power Supply
1730  OUTPUT @Pwrsupply;"CAL:CURR:LEVel MAX"    ! set output to maximum cal value
1740  WAIT 2                                    ! allow output to settle
1750  OUTPUT @Dmm;"MEAS:VOLT:DC?"               ! measure output with Dmm and
1760  ENTER @Dmm;Dmm_rdg                        ! store in variable Dmm_rdg
1770  Dmm_rdg=Dmm_rdg/Current_shunt             ! scale reading to amps
1780  PRINT Dmm_rdg
1790  OUTPUT @Pwrsupply;"CAL:CURR:DATA ";Dmm_rdg  ! send stored value to Power Supply
1800  OUTPUT @Pwrsupply;"OUTP OFF"              ! Turn off Power Supply output
1810  OUTPUT @Pwrsupply;"SYST:ERR?"
1820  ENTER @Pwrsupply;Error$
1830  !
1840  ! Check to see if there is an error.  If there is an error,
1850  ! display the error and exit the program.

1860  !
1870  CLEAR SCREEN
1880  IF Error$="+0,""No error""" THEN
1890    PRINT "Current calibration completed for Power Supply "
1900  ELSE
1910    PRINT "ERROR:";Error$;"Current not Calibrated"
1920    BEEP
1930    GOTO 2250
1940  END IF
1950  CLEAR SCREEN
1960  PRINT TABXY(10,5),"CURRENT CALIBRATION COMPLETE"
1970  PRINT TABXY(10,7),"BEGIN OCP CALIBRATION"
1980  WAIT 4
1990  CLEAR SCREEN
2000  OUTPUT @Pwrsupply;"OUTP ON"               ! Turn on Power Supply output
2010  OUTPUT @Pwrsupply;"CAL:CURR:PROT"         ! Perform OCP calibration
2020  WAIT 9                                    ! Allow OCP calibration to finish
2030  OUTPUT @Pwrsupply;"OUTP OFF"              ! Turn off Power Supply output
2040  OUTPUT @Pwrsupply;"SYST:ERR?"
2050  ENTER @Pwrsupply;Error$
2060  !
2070  ! Check to see if there is an error.  If there is an error,
2080  ! display the error and exit the program.
2090  !
2100  CLEAR SCREEN
2110  IF Error$="+0,""No error""" THEN
2120    PRINT "OCP calibration completed for Power Supply "
2130  ELSE
2140    PRINT "ERROR:";Error$;"OCP not Calibrated"
2150    BEEP
2160    GOTO 2250
2170  END IF
2180  CLEAR SCREEN
```

```
2190  PRINT TABXY(10,5),"CURRENT/OCP CALIBRATION COMPLETE"
2200  !
2210  ! Create a time stamp and output to power supply
2220  !
2230  Cal_msg$="Last Calibrated "&DATE$(TIMEDATE)&"  "&TIME$(TIMEDATE)
2240  OUTPUT @Pwrsupply;"CAL:STR """;Cal_msg$;""""
2250  OUTPUT @Pwrsupply;"CAL:SEC:STAT ON, ";Sec_code$
2260  OUTPUT @Pwrsupply;"VOLT:PROT:STAT ON"
2270  OUTPUT @Pwrsupply;"CURR:PROT:STAT ON"
2280  DISP "Calibration terminated. "
2290  END
```

2
Service

This chapter contains procedures for returning a failed power supply to Agilent for service or repair.

Operating Checklist

Before returning your power supply to Agilent for service or repair check the following items:

Is the power supply inoperative?

- Verify that the AC power cord is connected to the power supply.
- Verify that the front-panel power switch is depressed.
- Verify that the power-line fuse is installed:
  - Use the 4 AT, 250 V fuse for 100 Vac or 115 Vac operation.
  - Use the 2.5 AT, 250 V fuse for 230 Vac operation.
- Verify the power-line voltage setting.
  - Refer to the *E3632A User's Guide*.

Does the power supply fail self-test?

- Verify that the correct power-line voltage is selected.
  - Refer to the *E3632A User's Guide*.
- Remove all load connections to the power supply.
  - Ensure that all terminal connections are removed while the self-test is performed.

Types of Service Available

If your power supply fails within three years of original purchase, Agilent will repair or replace it free of charge. If your unit fails after your three year's warranty expires, Agilent will repair or replace it at a very competitive price. Agilent will make the decision locally whether to repair or replace your unit.

Standard repair service (worldwide)

Contact your nearest Agilent Service Center. They will arrange to have your power supply repaired or replaced.

Repacking for Shipment

For the Express Exchange Service described on the previous page, return your failed Agilent E3632A to the designated Agilent Service Center using the shipping carton of the exchange unit. A shipping label will be supplied. Agilent will notify you when your failed unit has been received.

If the instrument is to be shipped to Agilent for service or repair, be sure to:

- Attach a tag to the power supply identifying the owner and indicating the required service or repair. Include the instrument model number and full serial number.
- Place the power supply in its original container with appropriate packaging material.
- Secure the container with strong tape or metal bands.

If the original shipping container is not available, place your unit in a container which will ensure at least 4 inches of compressible packaging material around all sides for the power supply. Use static-free packaging materials to avoid additional damage to your unit.

NOTE Agilent recommends that you always insure shipments.

Electrostatic Discharge (ESD) Precautions

Almost all electrical components can be damaged by electrostatic discharge (ESD) during handling. Component damage can occur at electrostatic discharge voltages as low as 50 V.

The following guidelines will help prevent ESD damage when serving the power supply or any electronic device.

- Disassemble instruments only in a static-free work area.
- Use a conductive work area to dissipate static charge.
- Use a conductive wrist strap to dissipate static charge accumulation.
- Minimize handling.
- Keep replacement parts in original static-free packaging.
- Remove all plastic, styrofoam, vinyl, paper, and other static-generating materials from the immediate work area.
- Use only anti-static solder suckers.

Surface Mount Repair

Surface mount components should only be removed using soldering irons or desoldering stations expressly designed for surface mount components.

NOTE Use of conventional solder removal equipment will almost always result in permanent damage to the printed circuit board and will void your Agilent factory warranty.

To Replace the Power-Line Fuse

The power-line fuse is located within the power supply's fuse-holder assembly on the rear panel (refer to the *E3632A User's Guide*). For 100 Vac or 115 Vac operation, you must use a 4 AT slow-blow fuse (Agilent part number 2110-0996). For 230 Vac operation, you must use a 2.5 AT slow-blow fuse (Agilent part number 2110-0999).

To Disconnect the Output Using an External Relay

When the output of the E3632A is turned off, it is implemented by setting the output to 0 V and 0.02 A. This gives a zero output voltage without actually disconnecting the output. To disconnect the output, an external relay must be connected between the output and the load. A TTL signal of either low true or high true is provided to control an external relay. This signal can only be controlled with the remote command `OUTPut:RELay {OFF|ON}`. The TTL output is available on the RS-232 connector pin 1 and pin 9.

When the `OUTPut:RELay` state is **ON**, the TTL output of pin 1 is high (4.5 V) and pin 9 is low (0.5 V). The levels are reversed when the `OUTPut:RELay` state is **OFF**.

NOTE

- TTL output of pin 1 or pin 9 of the RS-232 connector is available only after installing two jumpers inside the power supply. See below for more information.
- Do not use the RS-232 interface if you have configured the power supply to output relay control signals. Internal components on the RS-232 circuitry may be damaged.

Installation procedure for an external relay

The assembly drawings are located in "Component Locator Diagram" on page 61.

1 Remove the front and rear bumpers and take off the cover.

2 Install JP3[1] and JP4[1] located adjacent to the connector P5 (refer to "Component locator diagram for the main board assembly — top" on page 61). A bare wire may be used.

3 Reassemble the power supply.

[1] For serial MY53xx6xxx, install JP751 and JP752 located adjacent to the connector CN751 (refer to "Component locator diagram for the main board assembly — top (serial MY53xx6xxx)" on page 63)

Troubleshooting Hints

This section provides a brief check list of common failures. Before troubleshooting or repairing the power supply, make sure that the failure is in the instrument rather than any external connections. Also make sure that the instrument is accurately calibrated. The power supply's circuits allow troubleshooting and repair with basic equipment such as a digital multimeter and a 100 MHz oscilloscope.

CAUTION

This instrument contains CMOS integrated circuits which are susceptible to failure due to electrostatic discharge. Refer to the “Electrostatic Discharge (ESD) Precautions” on page 51 for further handling precautions.

Unit is inoperative

- Verify that the AC power cord is connected to the power supply.
- Verify that the front-panel power switch is depressed.
- Verify that the power-line fuse is installed:
  - Use the 4 AT, 250 V fuse for 100 Vac or 115 Vac operation..
  - Use the 2.5 AT, 250 V fuse for 230 Vac operation..
- Verify the power-line voltage setting.
  - Refer to the *E3632A User’s Guide*.

Unit reports errors 740 to 750

These errors may be produced if you accidentally turn off power the unit during a calibration or while changing a non-volatile state of the instrument. Recalibration or resetting the state should clear the error. If the error persists, a hardware failure may have occurred.

Unit fails self-test

Verify that the correct power-line voltage setting is selected. Also, ensure that all terminal connections are removed while the self-test is performed. Failure of the DAC U21[1] on the top board will cause many self-test failures.

Bias supplies problems

Check that the input to the voltage regulators of the bias supplies is at least 1 V greater than their output.

Circuit failures can cause heavy loads of the bias supplies which may pull down the regulator output voltages.

Check the voltages of bias supplies as tabulated below.

Table 2-1 Bias supplies voltages

Bias supply	Minimum	Maximum	Check at
+5 V Floating	+4.75 V	+5.25 V	U11 pin 2
–5.1 V Floating	–4.75 V	–5.25 V	Anode of CR5
+15 V Floating	+14.25 V	+15.75 V	Anode of CR9
–15 V Floating	–14.25 V	–15.75 V	Cathode of CR10

[1] For serial MY53xx6xxx, failure of the DAC U36 on the top board will cause many self-test failures.

Table 2-2 Bias supplies voltages (serial MY53xx6xxx)

Bias supply	Minimum	Maximum	Check at
+3.3 V Floating	+3.135 V	+3.465 V	U23 pin 3
+15 V Floating	+14.25 V	+15.75 V	Anode of CR7
–15 V Floating	–14.25 V	–15.75 V	Cathode of CR23

Some circuits produce their own local bias supplies from the main bias supplies. Be sure to check that these local bias supplies are active. In particular, the ADC (analog-to-digital converter), AC input, and front panel sections have local bias supplies. Always check that the power supplies are free of AC oscillations using an oscilloscope. Failure of bias supplies will cause many self-test failures.

Self-Test Procedures

Power-on self-test

Each time the power supply is powered on, a set of self-tests are performed. These tests check that the minimum set of logic and measurement hardware are functioning properly. The power-on self-test performs checks, which covers from 601 through 604 and 624 through 634. For serial MY53xx6xxx, the power-on self-test utilize the complete self-test, which covers from error codes 601 through 632.

Complete self-test

Hold any front panel key except the **Error** key for more than 5 seconds while turning on the power to perform a complete self-test. The power supply beeps when the test starts. The tests are performed in the order shown below.

Table 2-3 Self-test error messages

601	Front panel does not respond The main controller U17 (*U10 for serial MY53xx6xxx*) attempts to establish serial communications with the front panel controller U7 (*U602 for serial MY53xx6xxx*) on the front panel board. During this test, the U7 (*U602 for serial MY53xx6xxx*) turns on all display segments. Communication must function in both directions for this test to pass. If this error is detected during power-on self-test, the power supply will beep twice. This error is only readable from the remote interface.
602	RAM read/write failed This test writes and reads a 55h and AAh checker board pattern to each address of RAM U14. Any incorrect readback will cause a test failure. This error is only readable from the remote interface.
603	A/D sync stuck The main controller issues an A/D sync pulse to U17 and U18 to latch the value in the ADC slope counters. A failure is detected when a sync interrupt is not recognized and subsequent time-out occurs.

Table 2-3 Self-test error messages (continued)

604	A/D slope convergence failed The input amplifier is configured to the measure zero (MZ) state in the 10 V range. This test checks whether the ADC integrator produces nominally the same number of positive and negative slope decisions (±10%) during a 20 ms interval.
605	Cannot calibrate rundown gain This test checks the nominal gain between integrating ADC and the U17 on-chip ADC. This error is reported if the procedure can not run to completion due to a hardware failure.
606	Rundown gain out of range This test checks the nominal gain between the integrating ADC and the U17 on-chip ADC. The nominal gain is checked to ±10% tolerance.
607	Rundown too noisy This test checks the gain repeatability between the integrating ADC and the U17 on-chip ADC. The gain test (606) is performed eight times. Gain noise must be less that ±64 LSB's of the U17 on-chip ADC.
608	Serial configuration readback failed This test re-sends the last 3 byte serial configuration data to all the serial path (SERDAT, SERBCK, SERCLK). The data is then clocked back into U18 and compared against the original 3 bytes sent. A failure occurs if the data do not match. This tests checks the serial data path through U22.
609[1]	This test checks if the ADC hardware is functional. The main controller U10 establishes communication with the ADC and checks if there are any error bits set for the ADC's status reporting.
624	Unable to sense line frequency This test checks that the LSENCE logic input U17 is toggling. If no logic input detected, the power supply will assume a 50 Hz line operation for all future measurements.
625	I/O processor does not respond This test checks that communications can be established between U17 (*U10 for serial MY53xx6xxx*) and U4 (*U752 for serial MY53xx6xxx*) through the isolated (U6 and U7) (*U751 for serial MY53xx6xxx*) serial data link. Failure to establish communication in either direction will generate an error. If this condition is detected at power-on self-test, the power supply will beep and the error annunciator will be on.
626	I/O processor failed self-test This test causes the earth referenced processor U4 (*U752 for serial MY53xx6xxx*) to execute an internal, ram test. Failure will generate an error.
630	Fan test failed This test checks if the fan current is flowing. If the current is not detected at power-on self-test, the power supply will beep and the error annunciator will be on. Fan test fail could likely induce overtemperature condition in the power supply.

Table 2-3 Self-test error messages (continued)

631	System DAC test failed This test checks if the DAC hardware is functional. The main controller U17 (*U10 for serial MY53xx6xxx*) sends a reference voltage data to DAC and converts the DAC output to digital data to see if the digital data is within a valid range.
632	Hardware test failed This test checks the status of voltage and current error amplifiers for the power circuit of output1. If both amplifiers are not operational, the power supply will beep and the error annunciator will be lit on.

[1] This error message is only applicable for serial MY53xx6xxx.

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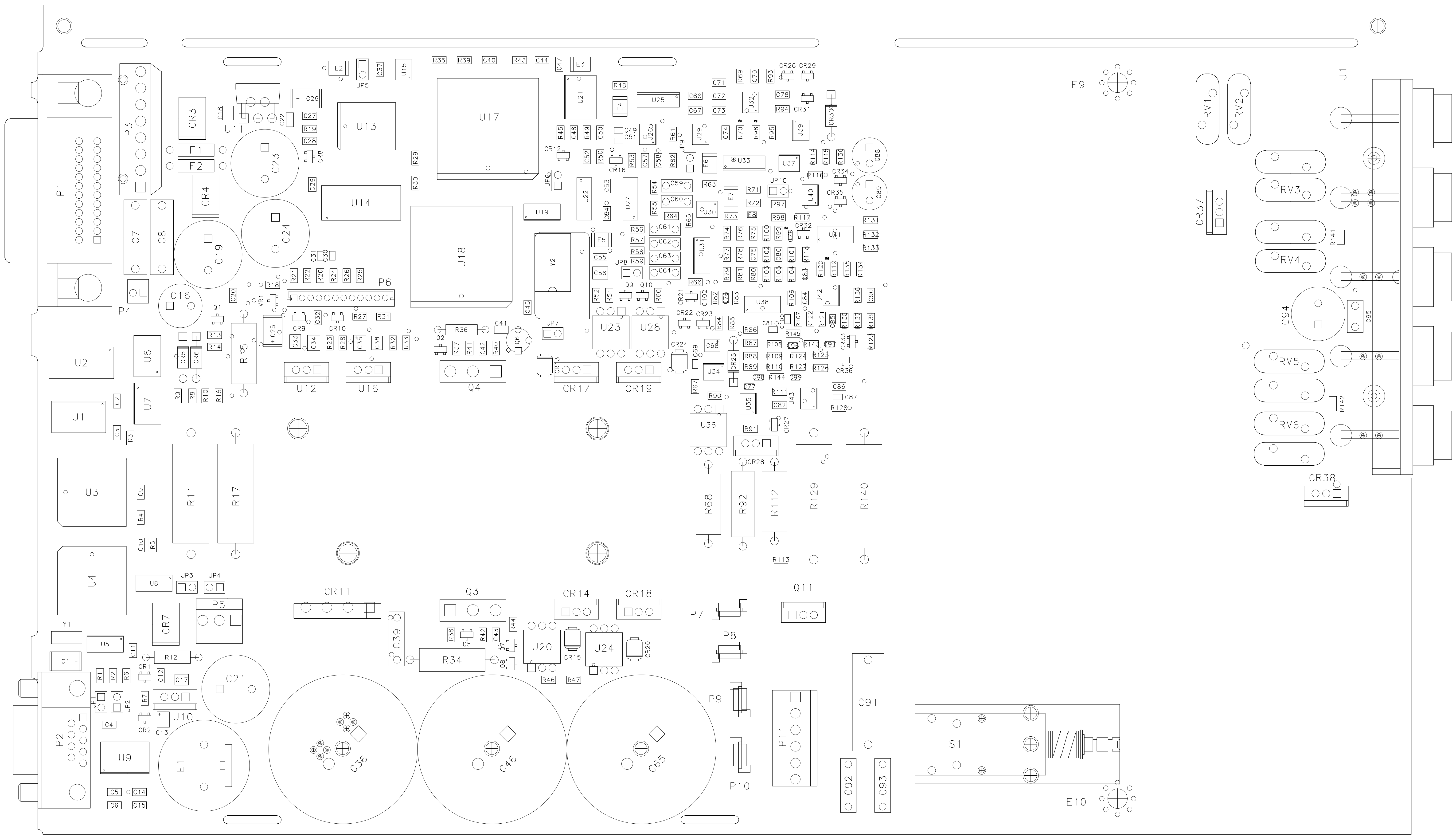
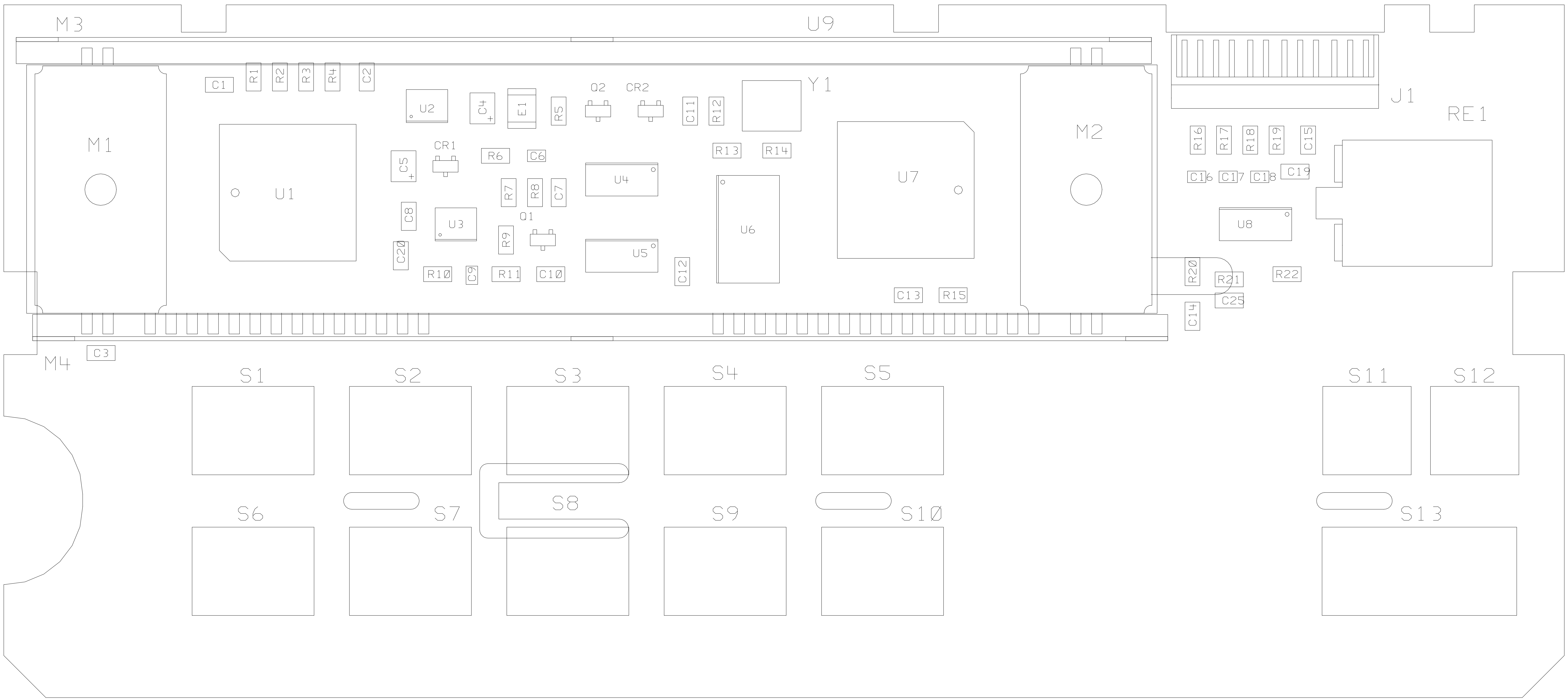
Component Locator Diagram

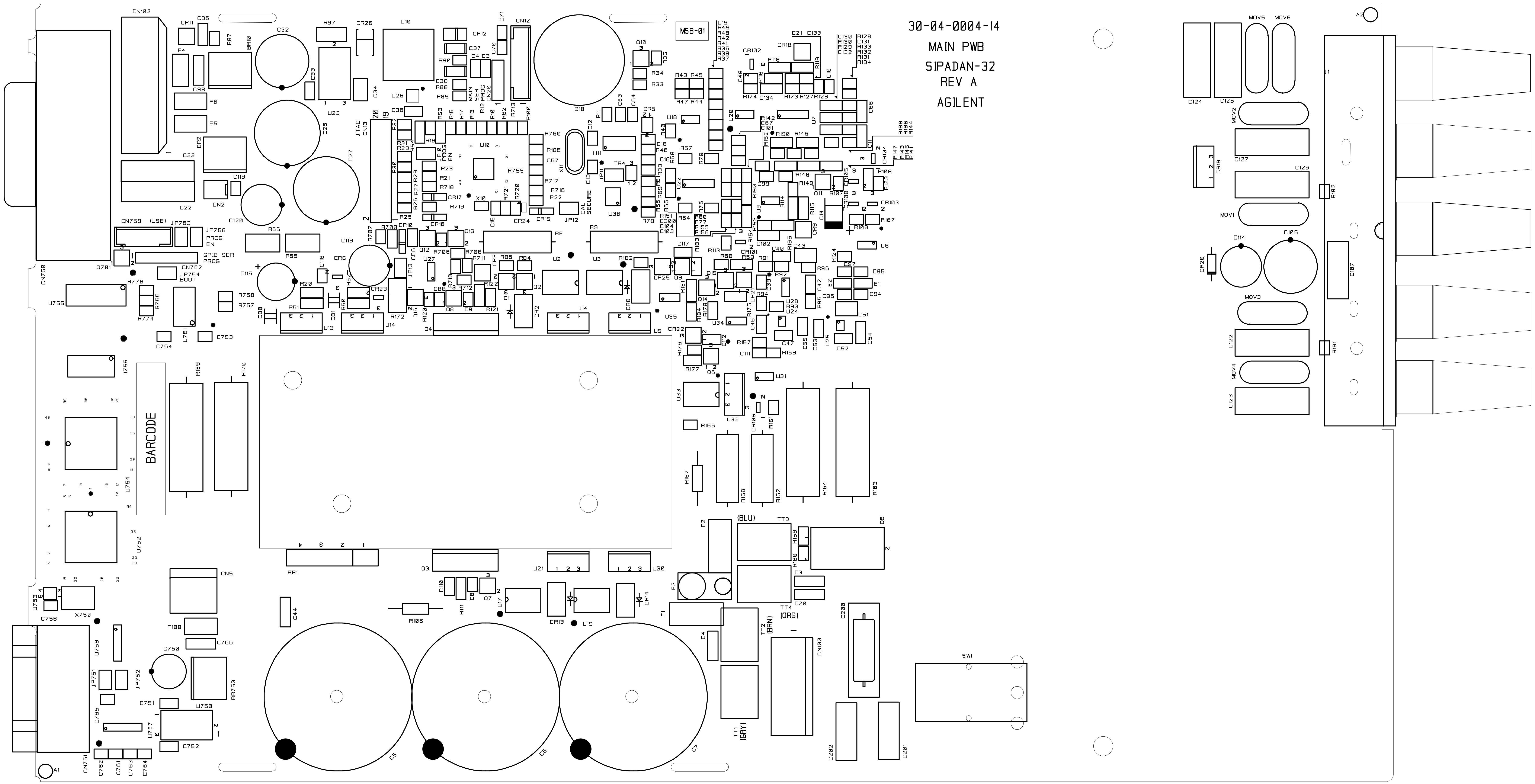
Component locator diagram for the main board assembly — top



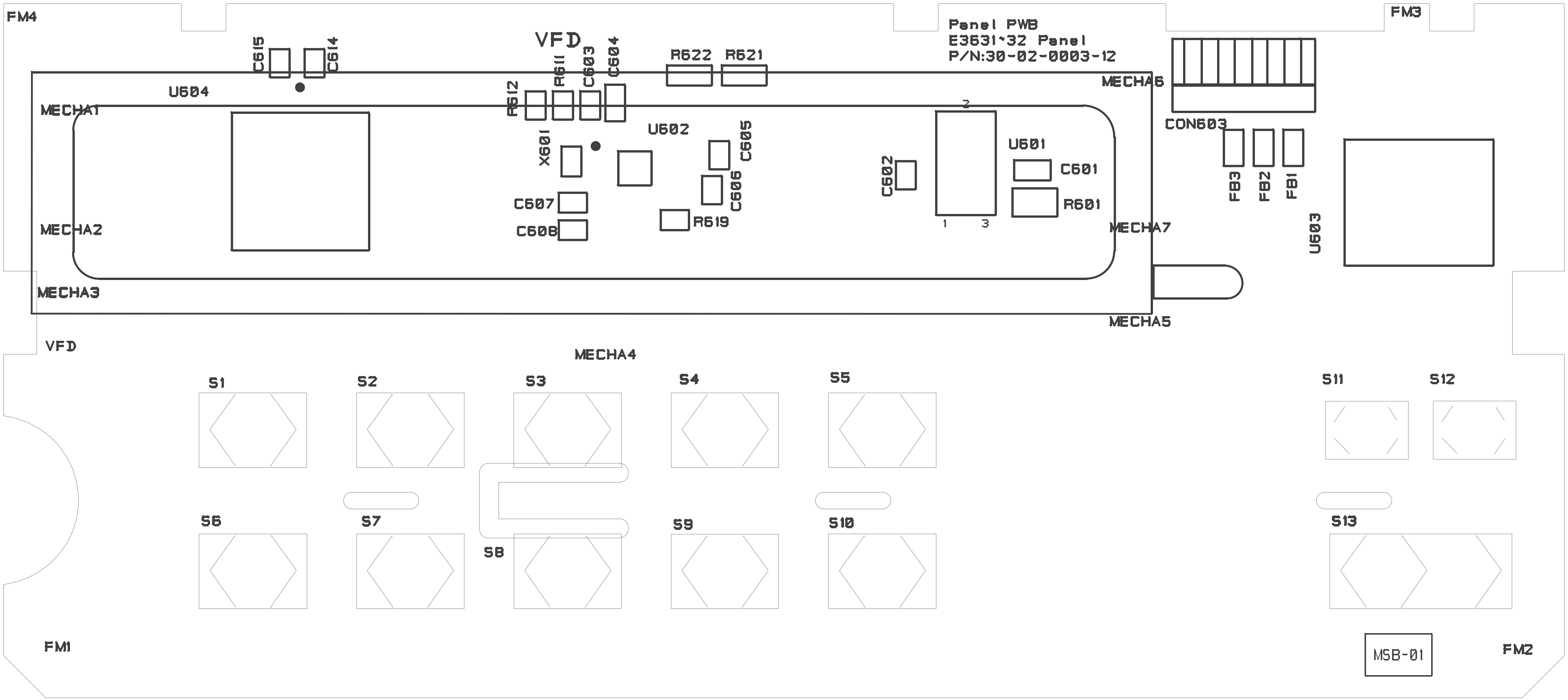
Component locator diagram for the front panel — top



Component locator diagram for the main board assembly — top (serial MY53xx6xxx)



Component locator diagram for the front panel — top (serial MY53xx6xxx)



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